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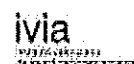
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ANIMAL FEEDING STRATEGIES TO REDUCE N₂O AND NH₃ EMISSION FROM SURFACE-APPLIED PIG SLURRY TO A GRASSLAND SOIL

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1. Introduction

It is estimated that N losses from fertilized crops range between 50-70%, depending on management practices, climate and soil conditions. Ammonia (NH₃) emissions following land application of animal manures give rise to a significant proportion of the total NH₃ emissions from agricultural sources (Misselbrook et al., 2002). Additionally, the increased amount of N and soluble organic carbon (SOC), associated with the application of slurries, may favour the emission of nitrous oxide (N₂O) and also affect the balance of other greenhouse gases (GHG) such as carbon dioxide (CO₂) (e.g. Amon et al., 2006). A large effort has been made in order to achieve a cost-effective reduction of N losses trying to minimize pollution swapping. In recent years, animal feeding strategies have been developed aiming to increase the N use efficiency of agrosystems (Arriaga et al., 2010). Most of this research has focused on NH₃ abatement but little is known about the combined effect of animal feeding on NH₃ and GHG emissions following slurry application. The main objective of this study was to evaluate the effect of five different feeds on the emissions of NH₃, N₂O and CO₂ from a grassland soil fertilized with pig slurries.

2. Materials and methods

A greenhouse experiment was carried out in the ETSI Agrónomos of the Technical University of Madrid between 29th November and 8th January. Five types of pig slurry (Table 1) were surface-applied in a randomized complete plot design with three replicates to a grassland (*Lolium perenne*) soil (*Calcic Haploxerepts*), previously collected from the field, air dried and sieved (2 mm). This soil has a clayey loam texture (28% clay, 17% silt, and 55% sand) in the upper horizon (0-28 cm). A soil with no fertilizer applied was used as a control. Samples of GHG were taken following the procedure of Abalos et al. (2013) from a closed static chamber (7.96 l). Concentrations of GHG were determined by gas chromatography. Ammonia emissions were measured by a dynamic chamber connected to a chemiluminescence analyser.

Table 1. N applied, N content and pH of applied slurries.

Treatment	N applied (kg N ha ⁻¹)	Total N (g kg ⁻¹)	Ammonium N (g kg ⁻¹)	pH
PSControl	100	9.91	5.32	8.89
Ga 7.5	100	7.97	3.75	8.38
Ga 15	100	9.72	4.35	8.2
Pn 7.5	100	8.71	4.53	7.93
Pn 15	100	7.84	3.41	8.08

"PSControl" refers to a slurry coming from pigs fed with barley (40%), wheat (45%) and soybean (10.30%); "Ga" refers to slurries produced by pigs fed with a mixture of "Garrofa" a by-product of the Carob tree (*Ceratonia siliqua*) (7.5 and 15% for Ga7.5 and Ga15, respectively); wheat (45%); barley (28.17 and 16.34% for Ga7.5 and Ga15, respectively) and soybean (13.21 and 16.12% for Ga7.5 and Ga15, respectively). "Pn" refers to slurries produced by pigs fed with a mixture of orange pulp (7.5 and 15% for Pn7.5 and Pn15, respectively); wheat (45%); barley (30.09 and 20.19%, respectively) and soybean (12.18 and 14.06% for Pn7.5 and Pn15, respectively).

3. Results and discussion

Application of slurries increased N₂O emission in all cases compared to the control (from 98.2% to 96% for PSControl and Pn7.5, respectively). The type of pig slurry had an effect on these emissions. Incorporation of by-products in the animals' diet decreased N₂O emissions from applied

slurry by 36.6 and 55.6% for Ga and Pn, respectively (Fig 1). This was probably related to the higher $\text{NH}_4^+\text{-N}$ of PSControl (Table 1). Application of slurries enhanced soil respiration (i.e. CO_2 fluxes) in all cases (64% on average), being this increase lower for PSControl (34.6%) (data not shown), possibly due to a reduction of plant biomass as a result of foliar damage following slurry application.

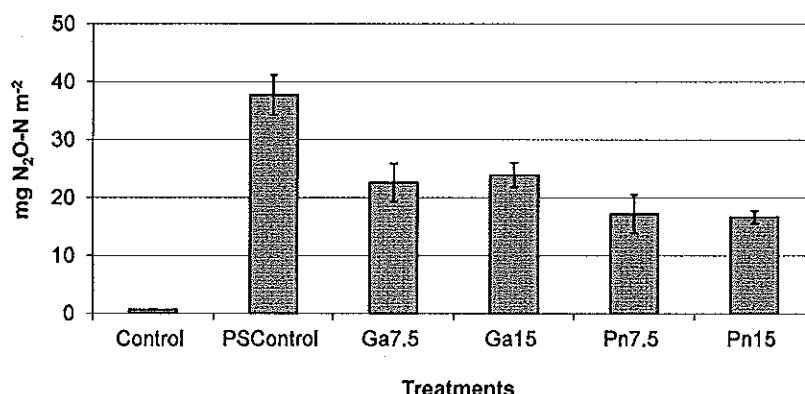


Fig 1. Cumulative N_2O emissions ($\text{mg N}_2\text{O-N m}^{-2}$).

Ammonia emissions were also enhanced by slurry application. Similarly, PSControl produced the highest emissions (50.6 and 9.2% higher than Ga and Pn, respectively) (data not shown).

4. Conclusions

Partial substitution of soybean and barley by "garrofa" and orange pulp in the diet of pigs reduced NH_3 and N_2O from slurry application under controlled conditions. These preliminary results may show the potential of alternative feeding strategies for the reduction of environmental problems associated with agriculture and for decreasing the external dependency of N imports for feeding animals in Spain. Further research under real conditions is needed to confirm these results.

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